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Report to the Test Director

BLAST MEASUREMENTS

Operation Tumbler-Snapper

Edited by

F. B. Porzel

Los Alamos Scientific Laboratory
University of California
August 1952

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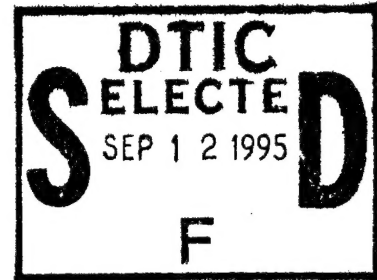
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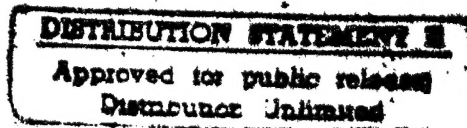
Operation Tumbler-Snapper

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(Project 19.2c)

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Part I

**BLAST-WAVE MATERIAL-VELOCITY
MEASUREMENTS (PROJECTS 19.2a AND b)**

by

Daniel F. Seacord, Jr.

ABSTRACT

The Operation Tumbler-Snapper material-velocity experiments were instrumented in a manner similar to that used on Operation Buster-Jangle. Methods of labeling air for photographic recording consisted of mortars and JATO's. In addition, the firing of high-altitude smoke projectiles from guns was included as a feasibility test for similar instrumentation on Operation Ivy.

Tumbler shots 1 to 4 and Tumbler-Snapper shots 5 and 8 were instrumented, and data were obtained on all shots. This part of the report discusses the analysis of data for peak material velocity and overpressure as a function of distance. Further data on time of arrival and thermal shock waves are presented; the latter are in preliminary form. Additional photographic records, not yet analyzed, are discussed, and the extent and value of such future analyses are briefly described.

Two appendixes present the analytical method of data reduction in detail.

~~SECRET~~ INFORMATION

ACKNOWLEDGMENTS

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M/Sgt Rafael L. Tafoya
Cpl Jack C. Campbell
Cpl Gabriel G. Casley
Cpl William W. Freeman
Cpl Frank B. Luchini
Cpl Richard L. Ring

Without the photographic services of Edgerton, Germeshausen & Grier, the extent of the experiment would have been severely limited.

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CHAPTER 1

OBJECTIVES

1.1 METHODS OF LABELING AIR

The feasibility of the material-velocity (or "mass-motion") method of measuring peak overpressures associated with a nuclear detonation was demonstrated in Operation Buster-Jangle. The two air-labeling methods there employed (mortars and JATO's) were again used on Operation Tumbler but on a much larger scale. A larger number of stations were instrumented, and there was greater camera coverage by Edgerton, Germeshausen & Grier (EG&G). In addition, a third method of labeling the air for photographic recording was employed. It was essentially a feasibility test for Operation Ivy, but when employed on two shots of Operation Snapper it also provided an independent pressure measurement for calibration of the parachute gauges of Project 1.1. This method involved firing a 90-mm smoke projectile, fuzed to burst at an altitude (1) comparable to the height of bomb burst for the airdrops and (2) above the burst height for the two tower shots on which the method was employed.

1.2 MATERIAL-VELOCITY METHOD OF PRESSURE MEASUREMENT

In relation to the over-all blast-measurement program, the material-velocity method of pressure measurement provided (1) data in a region not covered by other instrumentation and (2) an independent method of pressure measurement in the regions so instrumented. The region of 100 to 300 ft above the blast line was covered by mortar bursts and JATO columns, whereas the experiments conducted by other projects along the blast line were limited to altitudes of 50 ft. The 90-mm gun bursts provided information at and above the altitude of the bomb burst; thus additional data in the region covered by the rockets of Project 1.5 were provided by an independent method.

1.3 ADDITIONAL INFORMATION

Although the present report is concerned solely with the determination of peak overpressure as a function of distance, the material-velocity method is a means of studying many of the hydrodynamic variables associated with the blast wave. Future analysis of the data on hand from Operations Buster-Jangle and Tumbler-Snapper can eventually result in a detailed "blue-print" of the blast wave as a function of time.

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CHAPTER 2

BACKGROUND

2.1 RÉSUMÉ OF PREVIOUS WORK

2.1.1 General Analytical Method

The development of the material-velocity method of measurement of the hydrodynamic variables associated with a nuclear explosion has been discussed in the J-10 Buster-Jangle report.¹ The following is a brief description of the general method. Parcels of air are labeled with smoke, and the motion of this visible cloud, when struck by the blast wave, is then recorded photographically. Analysis of the film provides data on the displacement of the smoke cloud, and, with the known camera speed, a displacement-time curve may be drawn. The material velocity associated with the peak overpressure of the blast wave is taken to be the maximum slope of the displacement-time curve. This velocity, u , together with values of ambient sound velocity, c_0 , and ambient pressure, P_0 (from meteorological soundings), when applied to the proper Rankine-Hugoniot equation,* permits the calculation of the peak overpressure, P . From knowledge of the location of the smoke clouds in relation to the bomb-detonation point, a pressure-distance curve may be derived.

2.1.2 Mortars and JATO's

Two methods of labeling the air with smoke particles were employed in Operation Buster-Jangle: (1) JATO (jet-assist-take-off) units, which provided a column approximately 150 ft high, and (2) aerial "salutes" (fired from a 3-in. mortar), which burst from 100 to 350 ft above the ground (depending on the ballistics of the salute-mortar system employed). The Buster-Jangle results indicated that the aerial salute was the better method; however, one film of a JATO unit depicted the passage of the triple point through the cloud, thereby providing data on pressures in the free-air and Mach reflection regions. These results led to the decision on instrumentation for Tumbler-Snapper. Salutes were intended as the primary method, supplemented by JATO units in anticipation of determining the path of the triple point.

2.2 FEASIBILITY TEST OF HIGH-ALTITUDE MEASUREMENTS

As a feasibility test for Operation Ivy, a third method of labeling the air was introduced. This method consisted of firing white-phosphorus shells, fuzeed for air burst, from 90-mm

$$* \frac{u}{c_0} = \frac{1}{\gamma} \frac{P}{P_0} \frac{1}{\sqrt{\frac{\gamma+1}{2\gamma} \cdot \frac{P}{P_0} + 1}}$$

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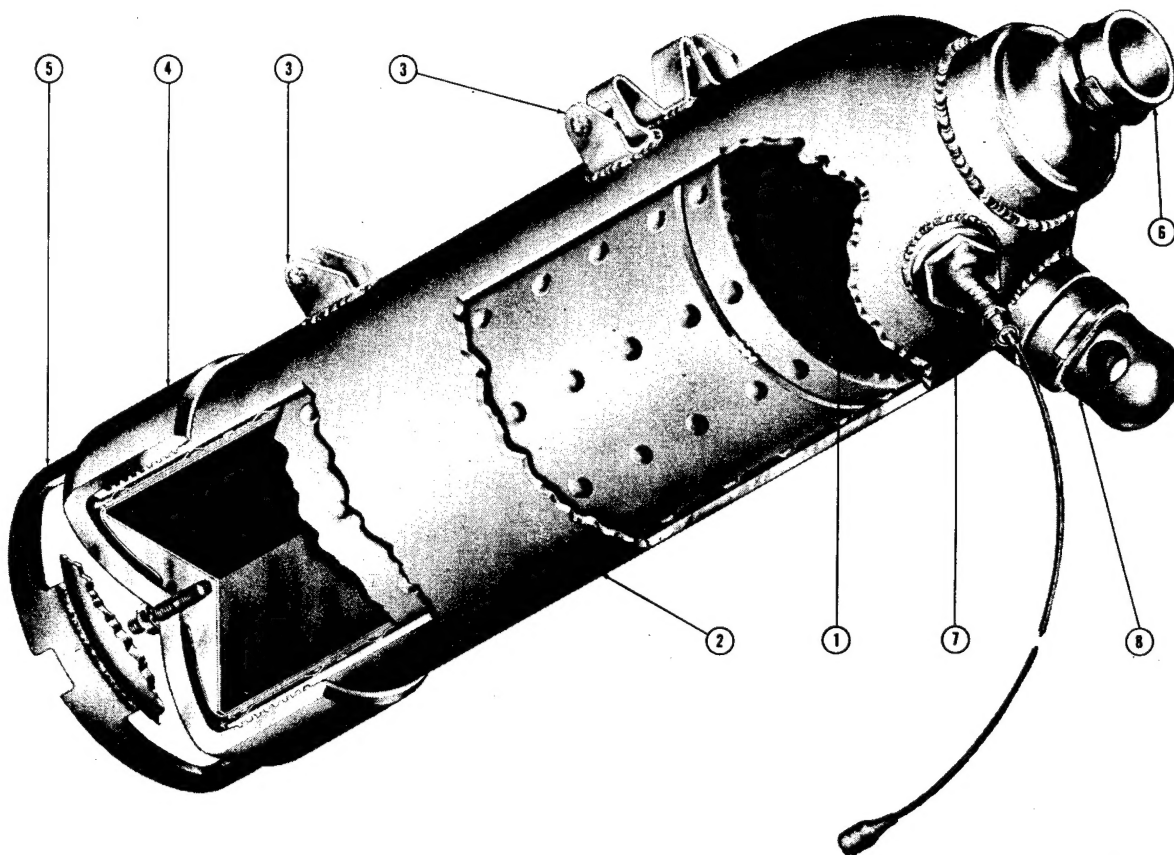


Fig. 2.1—JATO construction. 1, propellant cartridge. 2, chamber assembly. 3, attachment fittings. 4, forward closure cap. 5, ring-stand. 6, nozzle assembly. 7, igniter assembly. 8, safety pressure release assembly.

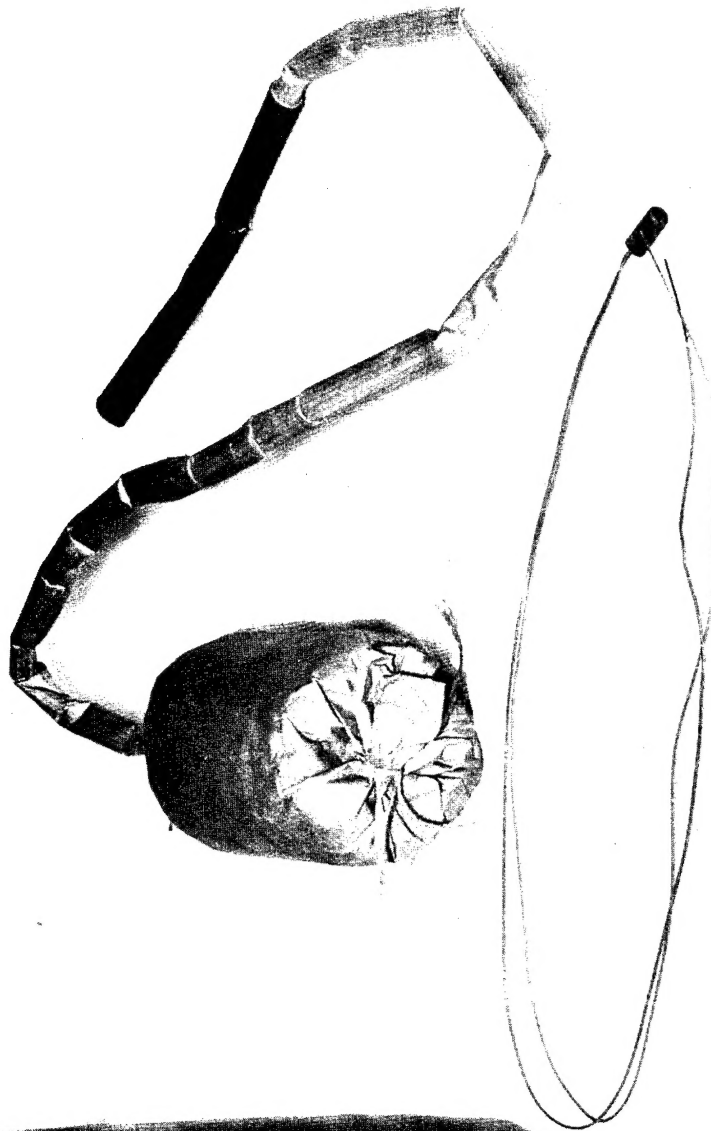
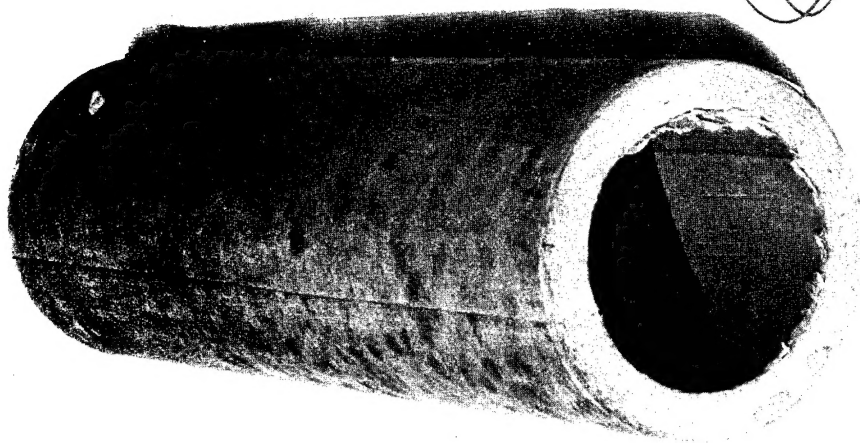


Fig. 2.2—Mortar, canister, and fuze: components.

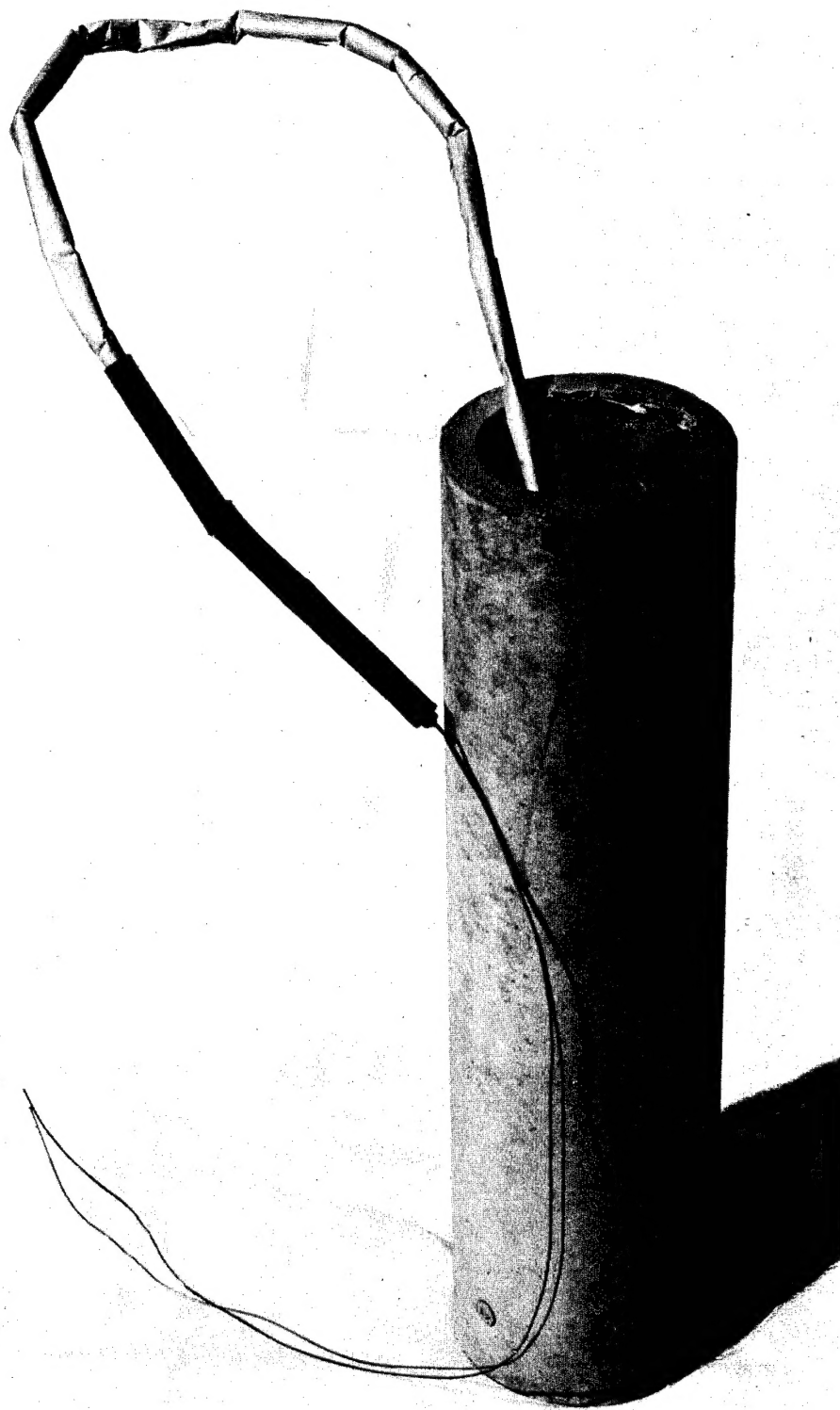


Fig. 2.3—Assembled mortar unit.

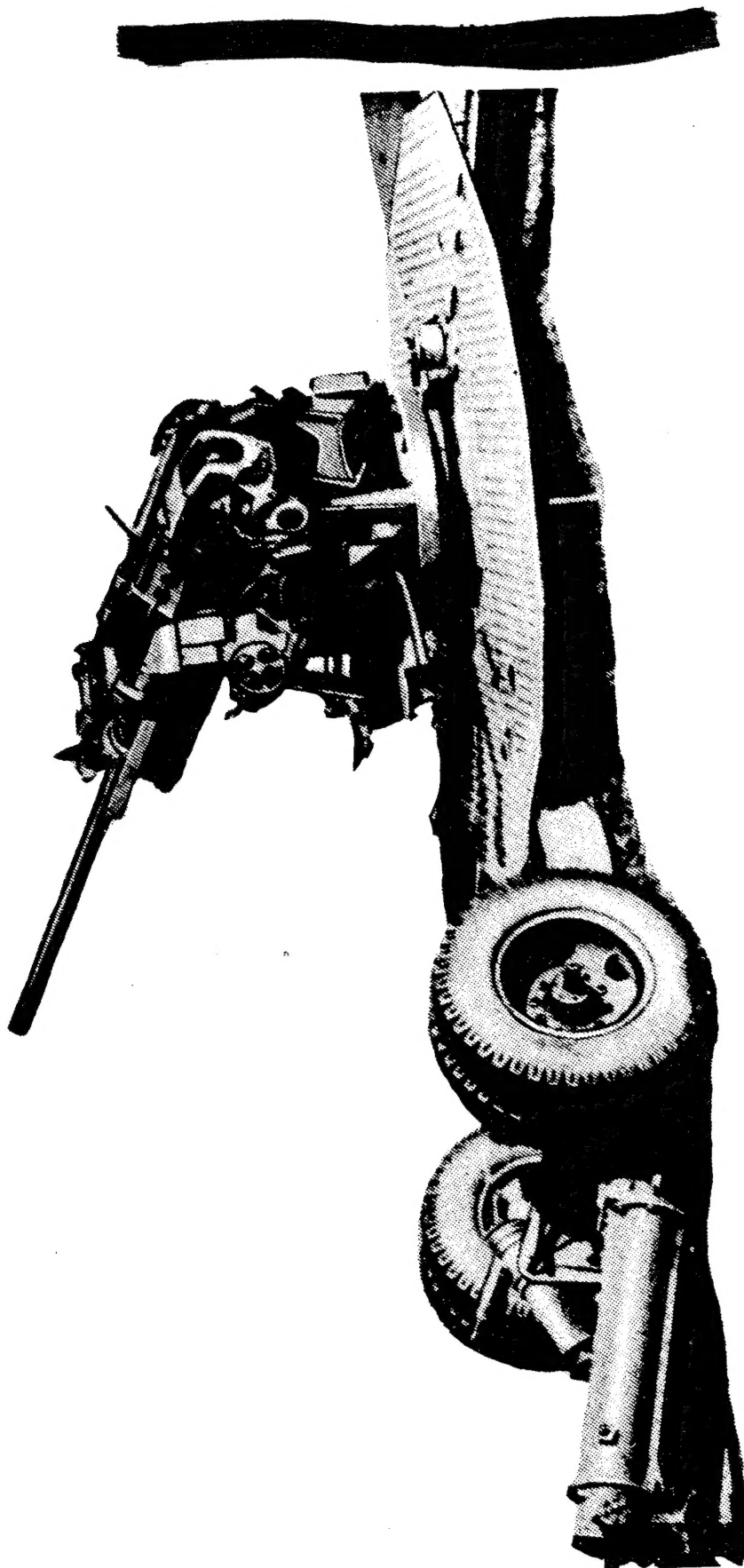


Fig. 2.4—90-mm antiaircraft gun.